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On the Masses of the Secondary Stars in CVs

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Abstract. Recent theoretical efforts have made predictions for the masses of the secondary stars in cataclysmic variables. Accurate observational determinations for M_2 are sparse and typically have uncertainties near $\pm 0.1 M_\odot$. How well do theory and observation agree?

1. Secondary Star Masses

Theoretical work by Beuermann et al. (1998), Baraffe, and Kolb (2000), and Howell et al. (2001) and references therein have developed detailed models which provide mass estimates for CV secondaries as a function of orbital period. All of these works are in fair agreement and propose that most secondary stars in systems with short orbital periods (< 5.5 hr) are more or less the most "normal" secondary stars in any CV. Additionally, these authors conclude that as a CV evolves towards the top of the period gap, the secondary will become bloated, as it is not in thermal equilibrium, and attain a larger radius for its mass compared with a main sequence counterpart. Details of the expected observational properties of these bloated secondaries can be found in Howell (2001).

Observational work by a number of authors has been compiled by Smith and Dhillon (1998) and from that work we find that there are only 16 CVs with orbital periods under 5.5 hr which have reliable mass estimates (i.e., with well determined uncertainties) for the secondary star.

Using the theoretical work of Howell et al. (2001) as an example for the evolution of CVs, in particular the evolution and properties of the secondary stars, we plot their expected relation for M_2 as a function of orbital period (dashed line) in Figure 1. Also included (solid line) is the relation expected for main sequence stars of radius equal to the Roche Lobe radius at a given orbital period. Over-plotted in Figure 1 are the sixteen reliable M_2 masses from Smith and Dhillon.

We can easily see from Figure 1 that at present, the observational data can not in general confirm or deny whether the theoretical models are correct. Only five of the masses have sufficiently small uncertainties to be useful, and of those, the two above the period gap seem to favor the theoretical model while below the gap the three well determined values fall below both relations. What is needed to help solve this issue are more, accurate determinations of the masses of the secondary stars in CVs. These are likely to come about through the use of high S/N IR spectroscopy obtained with large (>4m) telescopes.

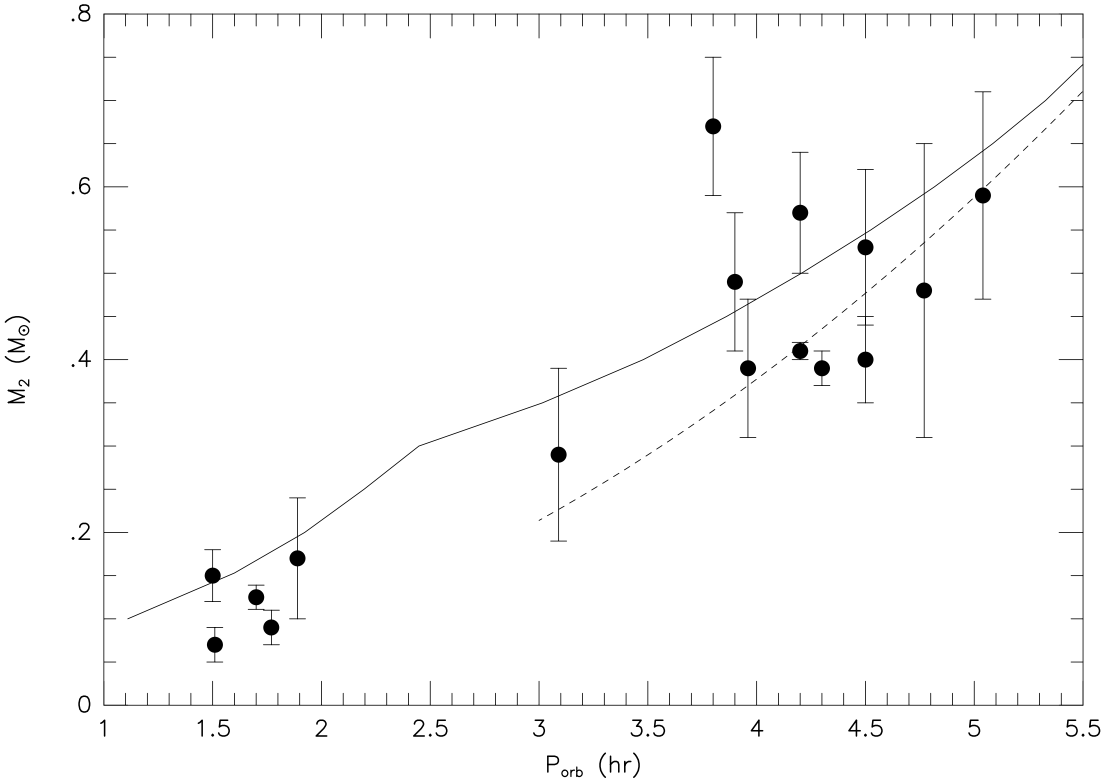

Figure 1. Theory vs. Observation. Plotted are the secondary star mass vs. orbital period for three sets of data; *Solid line* - the mass–orbital period relation for normal (single) main sequence stars assuming a radius for the star equal to the Roche Lobe radius of the secondary, *Dashed line* - the mass–orbital period relation from Howell et al. (2001) for mass losing CV secondaries, *Points* - the sixteen reliable secondary star masses from Smith and Dhillon (1998). We note that the dashed line essentially matches the solid curve for orbital periods below 2.5 hr.

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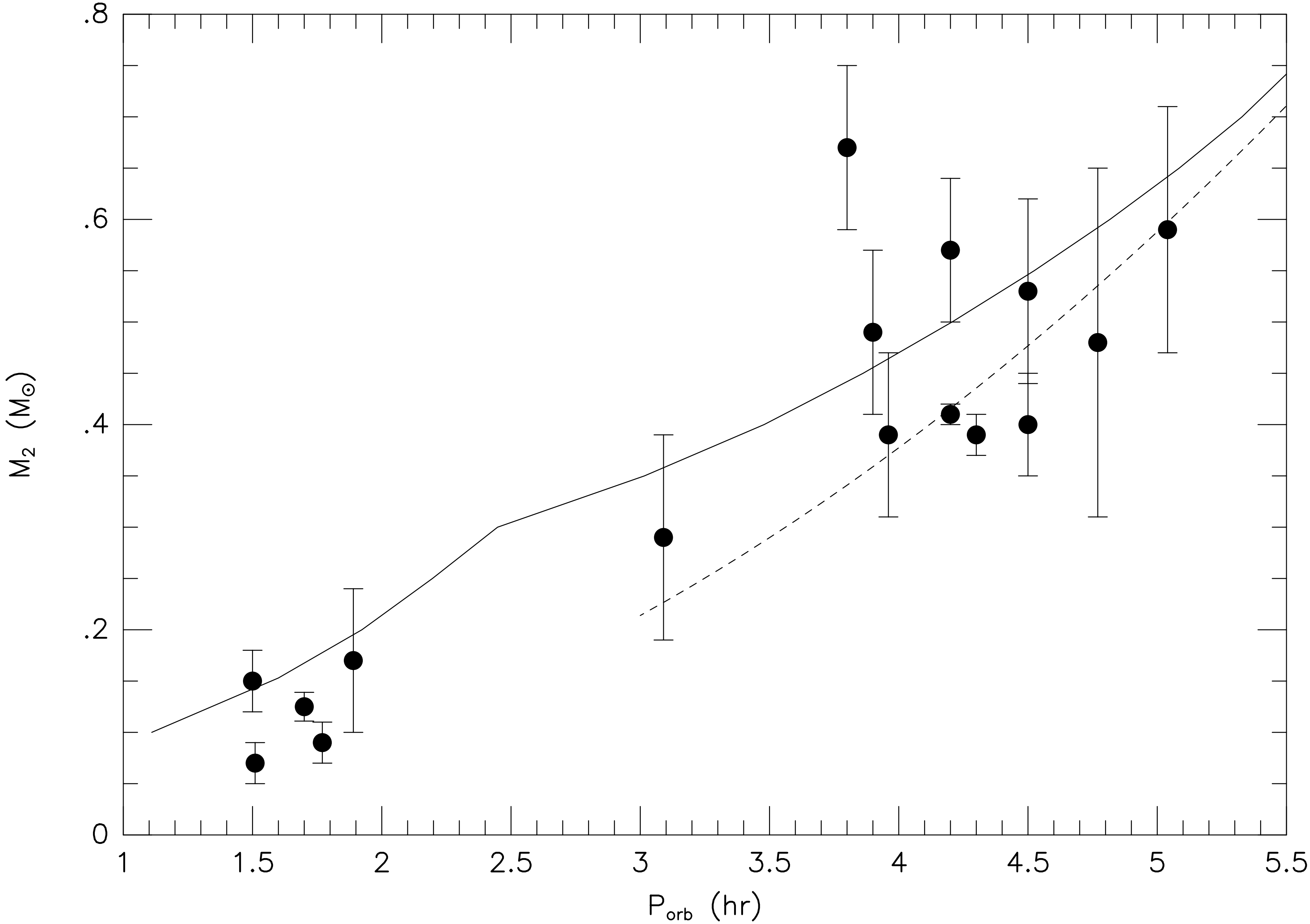

.8
.6
.4
.2
0
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
M_2 ($M_\odot$)
P_{orb} (hr)